Assignment-based Subjective Questions

1. From your analysis of the categorical variables from the dataset, what could you infer about their effect on the dependent variable? (3 marks)

Ans:

- The demand of bike is less in the month of spring when compared with other seasons
- The demand bike increased in the year 2019 when compared with year 2018.
- Month Jun to Sep is the period when bike demand is high. The Month Jan is the lowest demand month.
- Bike demand is less in holidays in comparison to not being holiday.
- The demand of bike is almost similar throughout the weekdays.
- The bike demand is high when weather is clear however demand is less in case of Light snow and light rainfall.

2. Why is it important to use drop first=True during dummy variable creation? (2 mark)

Ans:

- drop_first=True is important to use, as it helps in reducing the extra column created during dummy variable creation. Hence it reduces the correlations created among dummy variables.

3. Looking at the pair-plot among the numerical variables, which one has the highest correlation with the target variable? (1 mark)

Ans:

- atemp and temp both have same correlation with target variable of 0.63 which is the highest among all numerical variables

4. How did you validate the assumptions of Linear Regression after building the model on the training set? (3 marks)

Ans:

Linear relationship

One of the most important assumptions is that a linear relationship is said to exist between the dependent and the independent variables. If you try to fit a linear relationship in a non-linear data set, the proposed algorithm won't capture the trend as a linear graph, resulting in an inefficient model. Thus, it would result in inaccurate predictions.

The simple way to determine if this assumption is met or not is by creating a scatter plot x vs y. If the data points fall on a straight line in the graph, there is a linear relationship between the dependent and the independent variables, and the assumption holds.

No auto-correlation or independence

The residuals (error terms) are independent of each other. In other words, there is no correlation between the consecutive error terms of the time series data. The presence of correlation in the error terms drastically reduces the accuracy of the model. If the error terms are correlated, the estimated standard error tries to deflate the true standard error.

Conduct a Durbin-Watson (DW) statistic test. The values should fall between 0-4. If DW=2, no auto-correlation; if DW lies between 0 and 2, it means that there exists a positive correlation. If DW lies between 2 and 4, it means there is a negative correlation. Another method is to plot a graph against residuals vs time and see patterns in residual values.

No Multicollinearity

The independent variables shouldn't be correlated. If multicollinearity exists between the independent variables, it is challenging to predict the outcome of the model. In essence, it is difficult to explain the relationship between the dependent and the independent variables. In other words, it is unclear which independent variables explain the dependent variable.

Use a scatter plot to visualise the correlation between the variables. Another way is to determine the VIF (Variance Inflation Factor). VIF<=4 implies no multicollinearity, whereas VIF>=10 implies serious multicollinearity.

Normal distribution of error terms

The last assumption that needs to be checked for linear regression is the error terms' normal distribution. If the error terms don't follow a normal distribution, confidence intervals may become too wide or narrow.
Check the assumption using a Q-Q (Quantile-Quantile) plot. If the data points on the graph form a straight diagonal line, the assumption is met.

5. Based on the final model, which are the top 3 features contributing significantly towards explaining the demand of the shared bikes? (2 marks)

Ans:

The top 3 features contributing significantly towards explaining the demand of the shared bikes

i) Weathersit light snow
ii) Yr 2019
iii) temp

General Subjective Questions

1. Explain the linear regression algorithm in detail. (4 marks)

   Ans:

   Linear regression is one of the very basic forms of machine learning where we train a model to predict the behaviour of your data based on some variables. In the case of linear regression as you can see the name suggests linear that means the two variables which are on the x-axis and y-axis should be linearly correlated.

   Mathematically, we can write a linear regression equation as:

   $y = a + bx$

   Here, x and y are two variables on the regression line. b = Slope of the line a = y-intercept of the line x = Independent variable from dataset y = Dependent variable from dataset

2. Explain the Anscombe's quartet in detail. (3 marks)

Ans:
Anscombe’s quartet comprises four datasets that have nearly identical simple statistical properties, yet appear very different when graphed. Each dataset consists of eleven (x,y) points. They were constructed in 1973 by the statistician Francis Anscombe to demonstrate both the importance of graphing data before analyzing it and the effect of outliers on statistical properties.

3. What is Pearson’s R? (3 marks)

Ans:
In statistics, the Pearson correlation coefficient (PCC), also referred to as Pearson's r, the Pearson product-moment correlation coefficient (PPMCC), or the bivariate correlation, is a measure of linear correlation between two sets of data. It is the covariance of two variables, divided by the product of their standard deviations; thus it is essentially a normalised measurement of the covariance, such that the result always has a value between −1 and 1. The Pearson's correlation coefficient varies between -1 and +1 where:
r = 1 means the data is perfectly linear with a positive slope (i.e., both variables tend to change in the same direction)
r = -1 means the data is perfectly linear with a negative slope (i.e., both variables tend to change in different directions)
r = 0 means there is no linear association
r > 0 < 5 means there is a weak association
r > 5 < 8 means there is a moderate association r > 8 means there is a strong association

Pearson r Formula

$$r = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum (x_i - \bar{x})^2 \sum (y_i - \bar{y})^2}}$$

4. What is scaling? Why is scaling performed? What is the difference between normalized scaling and standardized scaling? (3 marks)

Ans:

It is a step of data Pre-Processing which is applied to independent variables to normalize the data within a particular range. It also helps in speeding up the calculations in an algorithm.

Most of the times, collected data set contains features highly varying in magnitudes, units and range. If scaling is not done then algorithm only takes magnitude in account and not units hence incorrect modelling. To solve this issue, we have to do scaling to bring all the variables to the same level of magnitude.

Normalization/Min-Max Scaling:

- It brings all of the data in the range of 0 and 1. sklearn.preprocessing.MinMaxScaler helps to implement normalization in python.

Standardization Scaling:

- Standardization replaces the values by their Z scores. It brings all of the data into a standard normal distribution which has mean (μ) zero and standard deviation one (σ)

5. You might have observed that sometimes the value of VIF is infinite. Why does this happen? (3 marks)

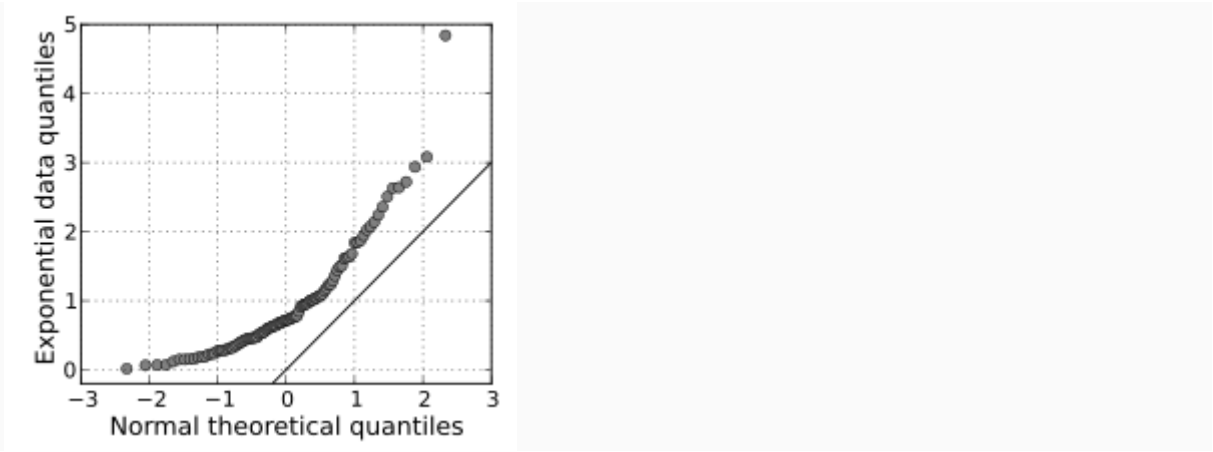
Ans: If there is perfect correlation, then VIF = infinity. This shows a perfect correlation between two independent variables. In the case of perfect correlation, we get R2 =1, which lead to 1/(1-R2) infinity. To solve this problem we need to drop one of the variables from the dataset which is causing this perfect multicollinearity. An infinite VIF value indicates that the corresponding variable may be expressed exactly by a linear combination of other variables (which show an infinite VIF as well).

6. What is a Q-Q plot? Explain the use and importance of a Q-Q plot in linear regression. (3 marks)

Ans:

Q-Q Plots (Quantile-Quantile plots) are plots of two quantiles against each other. A quantile is a fraction where certain values fall below that quantile. For example, the median is a quantile where 50% of the data fall below that point and 50% lie above it. The purpose of Q Q plots is to find out if two sets of data come from the same distribution. A 45 degree angle is plotted on the Q Q plot; if the two data sets come from a common distribution, the points will fall on that reference line.

A Q Q plot showing the 45 degree reference line:



If the two distributions being compared are similar, the points in the Q–Q plot will approximately lie on the line y = x. If the distributions are linearly related, the points in the Q–Q plot will approximately lie on a line, but not necessarily on the line y = x. Q–Q plots can also be used as a graphical means of estimating parameters in a location-scale family of distributions.

A Q–Q plot is used to compare the shapes of distributions, providing a graphical view of how properties such as location, scale, and skewness are similar or different in the two distributions.